

C U R A T O R I A L  
N E W S L E T T E R

Date: February 23, 1977

No. 13

*Michael B. Duke*

Michael B. Duke, Lunar Sample Curator

NEW DIRECTORATE FORMED

The Science and Applications Directorate has been combined with the Life Sciences Directorate to form a new organization known as the Space and Life Sciences Directorate. The new Director is Mr. Richard S. Johnston whom many of you will remember as the Manager of the LRL during the Apollo 11 mission. Owen Garriott will report to Johnston as Assistant Director for Space Science.

The Curatorial Branch is a part of the Lunar and Planetary Sciences Division--one of five divisions in the combined Directorate. Dr. Michael B. Duke has officially been named as the permanent Division Chief of the Lunar and Planetary Sciences Division. Dr. Duke will still retain the title and duties of the Lunar Sample Curator.

LUNA 24 ALLOCATION PLAN

In response to requests for material, the LSAPT has designed an allocation plan which represents a judicious use of the available sample. Some important considerations are given below:

. A core sample 160 cms long with a mass of 170 grams was collected from Mare Crisium by the Soviet automatic station Luna 24 on August 18, 1976. The Russians have agreed to provide seven samples, including six soils representing distinctive stratigraphic intervals spaced along the length of the core, plus a sample of what appears to be a uniform layer of crushed gabbroic rock that may represent either a rock fragment crushed by the drill, or a uniform ejecta layer similar to the layer observed in the Apollo 12 drive tube.

) . On opening in the laboratory, it was found that the upper 50-60 cm of the liner was empty, so the actual depth represented by any given layer must be considered undetermined.

. The following selection of samples are those considered in the allocation plan.

<u>Sample #</u>	<u>(Depth)</u>	<u>Weight</u>	<u>Description</u>
24077	77 cm	0.5 gm	Soil, close to top of soil retained in core.
24110	110 cm	0.5 gm	Soil, from broad undifferentiated upper unit.
24150	150 cm	0.5 gm	Soil
24173	173 cm	0.5 gm	Dark soil, from above sharp contact.
24182	182 cm	0.5 gm	Soil, distinctly lighter than unit above.
24210	210 cm	0.3 gm	Soil, dark.
24170	170 cm	0.2 gm	Crushed gabbroic fragment.

SAMPLE PROCESSING

The sieving of the six soil samples will begin with the 250  $\mu$ m screen rather than with the usual practice of pouring all material through a succession of coarser to finer meshes, so as to avoid contamination. All material that passes through the 250  $\mu$ m screen will be classified as "bulk soil." One-fifth of the bulk soil will be sieved to produce 150-250  $\mu$ m, 90-150  $\mu$ m, and less than 90  $\mu$ m fractions to be used for the preparation of polished thin sections for spectral reflectance studies. The unsieved four-fifths of the bulk soil will be allocated for chemical and isotopic measurements. The fraction retained on the 250  $\mu$ m screen will be sieved in 250-500  $\mu$ m, 500-1000  $\mu$ m, and <1000  $\mu$ m fractions and used for preparation of polished thin sections (250-500  $\mu$ m fractions) as well as chemical and isotopic studies (500-1000  $\mu$ m and <1000  $\mu$ m fractions).

Particles larger than 1000  $\mu\text{m}$  are to be examined by the Curator under the binocular microscope, photographed, described, and catalogued as individual specimens. Those between 500 and 1000  $\mu\text{m}$  in size will be photographed and catalogued as a batch for each of the six samples. Estimated percentages will be given of each type of rock, mineral, or glass fragment present. Allocations of all particles >500  $\mu\text{m}$  in size will be made only after they have been characterized as indicated above.

The feldspathic gabbroic rock 24170 will be directly split without prior sieving.

#### SAMPLE ALLOCATIONS

##### Group A. Soils : Mineralogy and Petrology

A consortium named FOCUS (Friends of Crisium Unmanned Samples) led by J. J. Papike and A. E. Bence of the University of New York at Stony Brook will receive polished thin sections of the 250-500  $\mu\text{m}$  soils. Papike and Bence will study the modal petrology and silicate geochemistry and then circulate the sections to S. Haggerty of the University of Massachusetts who will study the spinels and opaque oxides, to J. Goldstein at Lehigh University who will analyze the metal particles, phosphides, and carbides, and to E. Roedder of the United States Geological Survey and P. Weiblen of the University of Minnesota who will investigate the silicate melt inclusions.

Similar suites of polished thin sections of the 250-500  $\mu\text{m}$  soils will be allocated to K. Keil of the University of New Mexico, and to J. Wood at the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts. Both investigators plan complete modal surveys of particle types and petrographic and electron microprobe analyses of the lithic fragments and glasses. Additional polished thin section studies by L. Hollister at Princeton will emphasize pyroxene crystal chemistry as an indicator of the cooling history of their parent rock.

Polished thin sections of soils in the 150-250  $\mu\text{m}$  size fractions will be sent to L. Taylor at the University of Tennessee, who will study the chemistry of the glass-bonded agglutinates as it reflects the bulk composition of the soil, estimate cooling rates based on various geothermometer techniques, and analyze the opaque oxides. A similar suite of polished thin sections will be sent to M. Drake of the University of Arizona who has a continuing program of using petrographic and chemical surveys of lunar soils as a key to the igneous differentiation processes on the Moon.

L. Taylor will also receive polished thin sections of the 90-150  $\mu\text{m}$  soils. Other petrologists receiving polished thin sections of this fraction are W. Phinney of the Johnson Space Center, J. V. Smith of the University of Chicago, and H. O. A. Meyer of Purdue University.

Up to 50 mg of the <90  $\mu\text{m}$  fractions from samples 24077, 24110, 24150, 24173 and 24182 will be sent to J. Adams of the University of Washington for spectral reflectance measurements.

##### Group B Soils: Chemical and Isotopic Measurements

The backbone of the allocation is in two major cooperative efforts, both of which involve several Principal Investigators and a sizable group of Co-Investigators. The two consortia are: 1) G. J. Wasserburg, A. L. Albee, R. A. Schmitt, E. Anders (California Institute of Technology, Oregon State University, and University of Chicago; and 2) D. S. McKay, R. V. Morris, D. D. Bogard, D. Blanchard, G. E. Blanford (NASA-JSC and University of Houston). These efforts will yield optimal chemical, chronological, and petrological characterizations of the Luna 24 soils.

Studies outside of the consortia are W. Phinney (NASA-JSC) who will obtain a complete major element analysis, G. W. Reed (Argonne National Laboratory) who will study halogens (and a suite of other elements), L. E. Nyquist (NASA-JSC) and L. A. Haskin (Washington

University) who will provide minor and trace element characterizations. R. M. Walker (Washington University) and D. D. Bogard (NASA-JSC) will study records of galactic and solar radiation in the soil samples.

#### Feldspathic Gabbroic Rock 24170

The scientists who visited Moscow and had a preview of the Luna 24 samples report that this fragment may represent an igneous rock that has not been previously recognized among the lunar samples. It is of special interest even though it does not seem to represent a strictly local rock type. Because of the unique nature of the sample, it is felt that duplication of work should be held to a minimum. Roughly one-half of the mass is allocated to the consortium of G. J. Wasserburg, A. L. Albee, R. A. Schmitt, and E. Anders for petrologic descriptions, major, minor, and trace element characterizations, and--if possible--a firm age determination by one or several of the following methods: Rb-Sr, Pb-Pb, Sm-Nd,  $^{39}\text{Ar}$ - $^{40}\text{Ar}$ .

Fifteen mg of this sample will be used for preparation of three pristine thin sections for K. Keil, J. J. Papike, and J. A. Wood for a complete petrologic survey. These petrologists will rotate these sections among themselves such that each investigator will have an opportunity to examine the largest possible surface area available in polished thin sections. After completion of these studies, the sections will be available to other investigators. M. Tatsumoto (U.S. Geological Survey, Denver) will study uranium-thorium-lead systematics. Aliquots of the plagioclase separate, generated by the Wasserburg consortium are slated for allocations to R. M. Walker for track studies and to L. E. Nyquist for studies of strontium isotopes and of several trace or minor elements.

#### DRIVE TUBE 74001

This drive tube has recently been dissected and the first-round allocations are presently being prepared. The second-round dissection which will encompass the chemically pure layers is planned for the immediate future. A complete description of this drive tube is attached for your use in forming a sample request.

#### APOLLO 17 DRILL STRING

Section 70002 which is the lowest full section of the string is presently being dissected. A preliminary description has been completed with a final description expected by conference time. The following listing of the drill string sections and their state of preparation are noted for future reference.

70001 - Dissected (bottom portion)	70006 - Intact (next to be dissected)
70002 - Under dissection	70007 - Dissected
70003 - Intact	70008 - Dissected
70004 - Dissected	70009 - Dissected
70005 - Intact	

#### NEW CURATORIAL FACILITY

The bids for the new facility were opened on February 3, 1977. The official government estimate was \$1,960,890 with funds available of \$1,952,000. A contract was awarded to the Spaw-Glass Company of Houston who bid \$1,807,000. Construction will begin at the end of February and should take about 18 months.

#### LUNAR SAMPLE ANALYSIS PLANNING TEAM (LSAPT)

The current LSAPT Membership is attached for your interest and use. The members will be attending the Lunar Science Conference in March and will be available for questions concerning allocations and research.

### CURATORIAL STAFF

The current curatorial staff is listed here and they will also be in attendance at the conference.

Michael B. Duke  
John O. Annexstad  
Patrick Butler, Jr.

John W. Harris  
William A. Parkan  
Michael A. Reynolds

James E. Townsend

You are encouraged to discuss problems and direct your questions to them during the conference week.

Curatorial facilities such as the thin section room will be open on a first-come-first-serve basis. Please reserve a microscope in advance by calling Ms. Alene Simmons or Ms. Polly McCamey at 713-483-6241.

### APOLLO 11 CATALOGUE COMPLETED

The revised Apollo 11 catalogue has been finished and is now in reproduction. Copies will be mailed to Principal Investigators about the time of the conference. A limited number of reproductions have been ordered since the catalogue is costly. If more are needed, these will be reproduced as soon as the need becomes apparent.

### APOLLO 14 CATALOGUE TO BE REDONE

The next major project in the data line is to update the Apollo 14 catalogue. Dr. C. Meyer of the Lunar and Planetary Sciences Division has been asked to coordinate this effort and is presently gathering data. If you have pertinent information on early processing of the Apollo 14 samples, he would appreciate hearing from you.

---

2 Enclosures  
LSAPT Membership  
First Dissection of  
Drive Tube 74001

January 1977

# LSAPT MEMBERSHIP

Dr. Everett K. Gibson, Jr.  
NASA-Johnson Space Center  
SN7/Geochemistry Branch  
Houston, Texas 77058  
(713-483-6224) (FTS: 87-525-6224)

Dr. Dieter Heymann  
Rice University  
Department of Geology  
Houston, Texas 77001  
(713-527-8101 x-3336)  
(FTS: 87-527-4011)

Dr. Robert M. Housley  
Science Center, Rockwell Int'l  
1049 Camino Dos Rios  
Thousand Oaks, California 91360  
(805-498-4545) (FTS: 87-798-2000)

Dr. Klaus Keil (Vice-Chairman)  
University of New Mexico  
Department of Geology  
Institute of Meteoritics  
Albuquerque, New Mexico 87131  
(505-277-2747) (FTS: 87-474-5511)

Dr. Susan Kieffer  
University of California  
Department of Geology  
Los Angeles, California 90024  
(213-825-1601) (FTS: 87-508-825-1601)

Dr. Michael E. Lipschutz  
Purdue University  
Department of Chemistry  
Lafayette, Indiana 47907  
(317-749-2724) (FTS: 87-331-7000)

Dr. Kurt Marti  
University of California, San Diego  
Department of Chemistry  
P.O. Box 109  
La Jolla, California 92037  
(714-452-2939) (FTS: 87-895-5000)

Dr. Ursula Marvin  
Smithsonian Institute  
Astrophysical Observatory  
60 Garden Street  
Cambridge, Massachusetts 02138  
(617-495-7270) (FTS: 87-830-7270)

Dr. Edward Schreiber  
Lamont-Doherty Geological Observatory  
Columbia University  
Palisades, New York 10964  
(914-349-2900 x-338) (FTS: 87-883-2221)

Dr. Charles H. Simonds  
Lunar Science Institute  
3303 Nasa Road One  
Houston, Texas 77058  
(713-488-5200) (FTS: 87-527-4011) or  
NASA-JSC: 713-483-3616 (FTS: 87-525-381)

Dr. Lawrence A. Taylor  
University of Tennessee  
Department of Geology  
Knoxville, Tennessee 37916  
(615-974-2366) (FTS: 87-855-2366)

Dr. W. Randy Van Schmus  
University of Kansas  
Department of Geology  
Lawrence, Kansas 66004  
(913-864-3676) (FTS: 87-752-8661)

Dr. Hartmut Spetzler  
University of Colorado  
CIRES  
Boulder, Colorado 80309  
(303-492-8028) (FTS: 87-323-3151)

Mr. Richard S. Johnston, Chairman  
NASA-Johnson Space Center  
SA/Space and Life Sciences Directorate  
Houston, Texas 77058  
(713-483-2251) (FTS: 87-525-2251)

## FIRST DISSECTION OF DRIVE TUBE 74001

### INTRODUCTION

Drive tubes 74001 and 74002 are unusual in containing relatively homogeneous, unmixed orange and black soil of distinctive petrography and composition. Because of their unusual nature, the colored glass soils at Shorty Crater have been some of the most-studied material returned from the Moon (Meyer et al., 1975). Samples under study have come from a shallow trench at the lunar surface, and from the base of the double drive tube 74001, that was collected at the trench site. Because of the discontinuous nature of the sampling process, results have been tantalizingly incomplete. Examination of a suite of samples from the soil column returned in the drive tubes should shed more light on processes that formed the unusual glass bead deposits and should provide insight into lunar conditions at the time the soil was formed. The following information summarizes the first look at the soil column in drive tube 74001, and is a first step in understanding the history of the soil column represented therein.

### TIME-LINES AND HANDLING HISTORY

Drive tube 74001 was collected at Shorty Crater on December 1972, 5 days and 23 hours  $\pm$  3 minutes, into the Apollo 17 mission. The core was returned in Sample Return Container (SRC) 2, which was sealed in the lunar vacuum, and which held a vacuum of 28 microns Mercury (Butler et al., 1973, p. 39) until opened in the nitrogen cabinets in the Lunar Receiving Laboratory on January 3, 1973. Since that date, the core has been kept in dry N<sub>2</sub>, both in the Lunar Curatorial Laboratory (LCL) core storage cabinet, and when triple-bagged in the X-ray room. Weighing and dusting were completed January 8, 1973, and the core was first X-rayed on February 12, 1973. After description of the initial X-radiographs, it was found that the core was filled beyond designed capacity, so the bottom end was opened and 2.415 gm of soil was extracted for allocation and study. From February 22, 1973, until December 10, 1976, the core was stored in the LCL core storage cabinet. On the latter date, 74001 was

reradiographed, using improved equipment and new techniques; the description of this new X-radiograph appears in Fig. 2. On December 14, 1976, an initial attempt was made to extrude the core; because of the high density and internal content of cohesive soil polygons, the designed pressure capacity of the extruder was exceeded and the machine suffered repeated failures. The guide pins that held the extruding screw and attached ram sheared, placing torque on the core holder as well as the extrusion receptacle. This torque fractured the quartz top of the core receptacle, and pieces of quartz contaminated the uppermost part of the core, but otherwise did not cause much harm. Finally, a device was fabricated that held the ram screw in place well enough to extrude the core, although shavings and pieces of extruder came out of one end of the extrusion device at the same time the core came out of the other end! Immediately after extrusion, the outside surface was cleaned and photographed, and dissection of the uppermost plate layer was completed by January 21, 1977.

#### X-RADIOGRAPHY

Descriptions of original X-radiographs appear in Apollo 17 Sample Catalog (Butler et al., 1973) and Apollo 17 Preliminary Science Report (LSPET, 1973). 74001 was the least successful of the original radiographs because the drive tube was largely filled with black devitrified glass, which is nearly opaque to X-rays. Reradiography provided much new information, although still hindered by extreme opacity of core material. A description of the new X-radiograph appears in Fig. 2. Much more detailed information on internal structures is available, and nine units could be discerned on the basis of internal massiveness, shape and size of fracture polygons.

#### RELATIONSHIP TO SAMPLING SITE

74002/74001 was collected in the middle of a patchy deposit of orange glass, at a low area on the southwest rim of Shorty Crater, just east of a large boulder of fractured basalt (Fig. 1). At the sampling site, the orange glass deposit occupied a 1 x 2M ellipsoidal zone with

the long axis parallel to the crater rim (USGS AFGIT, 1975, p. 14). Extent of the orange area is documented in lunar surface photo AS17-137-20090. Contacts of the orange soil unit and surrounding grey soil are irregular and crenulate, but are roughly vertical, as seen in photos AS17-173-20987-20989. Color zoning within the orange soil area was also noted by the astronauts to be vertical (voice transcript 05 22 59+), with an outer band of yellowish soil grading inward to orange, and finally reddish soil on the innermost part of the orange glass deposit. The drive tube was driven straight down, rather than slantwise, to sample as much orange material as possible. To the surprise of the astronauts, the soil in both the lower and base of the upper drive tubes was nearly black (voice transcript 05 23 01+), with orange soil discoloring the outside of the upper drive tube to a depth of 25 cm. In addition to the core, samples of the orange soil (74220) and grey soils (74240, 74260) were taken from the Shorty Crater trench.

It is argued that the orange and black soil of 74002/74001 is a sample of stratified material that overlay the subfloor mare basalts, and which was deposited as an ejecta clast in the crater rim by the Shorty impact event. Previous authors (Wolfe et al., 1975) have interpreted Shorty as an impact crater, with the orange soil being Shorty ejecta. Origin of the orange deposit just above the subfloor basalts, was sketched in an outcrop mosaic by Heiken et al. (1974, p. 1706). The ejecta interpretation is sustained here, with the following additions to support the clast interpretation. (1) Patchy areas of colored soil are distributed widely on the southern rim of Shorty Crater. These areas can be recognized by discoloration of overlying surficials, both in close-up view at the trenching site (AS17-137-20990) and in more distant views in Panorama 19 (AS17-137-21007 through 21013). Distribution of areas of orange, black and grey soil in Pan 19 is sketched in Fig. 1, and occurrence of these colored soils is also indicated on the planimetric site map. (2) Areas of colored soil are approximately the same size as boulders known to be crater ejecta that occur in the same locality. (3) Bedding is discordant. Orange and black soil in the double drive tube is horizontally stratified--presumably the rest of the patch of orange and black soil where the sample was collected

is also horizontally stratified--but other apparent outcrop stratigraphy at the sampling site is vertical (voice transcript 05 22 59).

Presence of orange soil (1) which is horizontally stratified orange soil and which has vertical contacts with grey soil, (2) which occurs in irregular patchy distribution, with color patches the same size as known ejecta clasts, in the rim of a known impact crater, is best explained if the orange and black soil is a clast deposited in the crater rim by the Shorty event.

Most of the orange soil patches occur in the inner part of the rim crest (Fig. 1) whereas the light grey patches tend to occur toward the outer part of the rim crest, and the black patches occur mostly on top of the rim crest. If strata are overturned, as is the normal case in a crater rim, then the succession of colored soils atop the basaltic sub-floor is from orange to black to grey.

#### LUNAR SURFACE ORIENTATION

Unfortunately, all twelve sampling documentation photographs of 74001 and 74002 were blank, so orientation of the core must be inferred. In trench photographs, such as AS17-137-20990) the orange soil was somewhat cohesive, but fractured into polygons which had a prominent cleavage-like fracture trend dipping at approximately 60° toward the crater. Such an internal fracture pattern is seen in stereopair 1 of 74001; this stereopair is interpreted as being oriented radially to the crater. Stereopair 2 therefore is tangential to the crater.

#### MODIFICATIONS TO DISSECTION PROCEDURE

Because of unusually fine-grain size, standard dissection procedures could not be completely followed, although they were modified as little as possible. Standard 5 mm increments were used, and detailed description of each interval was followed immediately by extraction, sieving, and examination of soil from each dissection increment. However, because of the fine grain size (only 3 coarse particles were retained on the sieve) and lack of obvious texture changes, emphasis was placed on the study of the visible coarse fraction on the prepared surface. Maximum grain size

was recorded, types and color of droplets noted where possible. Next, areas were marked off on the surface of each interval, and all visible grains were classified according to their being single, double, or compound droplets. This procedure is designed to test for changes in grain type, and to look for incipient marbling that might be missed because of uniform color and apparently uniform texture. If two samples are statistically different in each interval, one could suspect marbling. This droplet examination procedure does have limitations: (1) only the coarsest material is examined because particles under 50 microns are too small to see with the dissecting scope, and (2) vitreous glass is disproportionately represented because black, devitrified glass shows up poorly in reflected light and is likely to be missed. During dissection, degree of cohesiveness and size of fracture polygons in each unit was noted.

#### DESCRIPTION OF STRATIGRAPHIC UNITS AND MAJOR UNITS

Lithologic units in 74001 closely reflect strata identified in new X-radiograms, although differences between units are minor and very subtle, both in X-radiograms and in the actual core. The entire core is fine-grained, dark-colored and is composed entirely of glass or devitrified glass, with no other rock types present. At first glance, the core appears to be completely homogeneous, and only careful study can resolve the minor variations to differentiate strata. Slight differences in opacity and internal fracture patterns enable recognition of strata in X-ray. During dissection, differences in nature of fracture cohesiveness, in abundance of large (over .1 mm) droplets, in abundance of single vs. compound reflective droplets, and in type of visible droplets enable some identification of strata during dissection. Because the core is almost opaque to X-rays, and appears uniformly dark in dissection, it is difficult to identify unit boundaries, and it is rarely clear whether the boundary is abrupt or transitional. Nevertheless, quantification of petrographic properties enables distinction of internally consistent trends; these trends are reflected in the stratigraphic units discussed below.

Although many thin strata can be seen in the core and interpreted in the X-radiograms, there are three lithologic successions or major units which are especially distinctive and noticeable, both in X-ray and in the exposed core. In upward succession, these major units are labelled "A", "B", and "C", with a letter designation to differentiate the major units from X-ray units (Roman numerals) and dissection units (numbers). Two of the major units are internally similar, and appear highly fractured to the X-ray: these major units occupy the top fourth and bottom half of the 74001 core. Lithologically, these major units look relatively dull to the eye, because of apparently higher content of fine, devitrified glass. Under detailed scrutiny, these strata appear to be more poorly sorted (or evenly sized) with some relatively large compound droplets, but no concentrations of droplets of any one size range. Large (.5 to .25 mm) droplets appear to be randomly distributed through the matrix in any given interval, although there are variations in abundance of droplets through any given major unit. Broken droplets are common. In X-ray these major units are internally fractured, and in dissection, the major units are relatively friable and break into flaky polygons.

On the other hand, the major unit that occupies the upper middle of the core, major unit "B", is massive in X-ray and cohesive in dissection. It appears relatively sparkling and reflective because of a high concentration of unbroken vitreous glass droplets in the .1-.25 mm size range. Internally, this major unit is well stratified and does not show the random fabric of the other major units, although concentrations of well-sorted droplets have not been seen during dissection.

In summary, the upper ("C") and lower ("A") major units are duller in appearance, richer in fine devitrified glass, and are poorer sorted with random internal fabric and flaky cohesiveness. The middle major unit is reflective in appearance, rich in unbroken, relatively large vitreous droplets, internally stratified and massively cohesive. Further lithologic differences enable identification of a number of units within these major units.

## DESCRIPTION OF UNITS

Unit 1, from 30.0 to 34.3 cm is relatively homogeneous, with large compound droplets. Grain sizes and abundance of single and compound droplets do not vary much through the unit, but there is an unusual horizontal alignment of large compound droplets at the top of the unit.

Units 2, 3, and 4 are similar. Each shows an upward increase in size, as represented in proportion of coarse fraction. There is a corresponding change in droplet type, with single droplets prevalent at the fine-grained base of the unit, followed by a maximum in double droplets, and succeeded in turn by a maximum in compound droplets (Fig. 4). Changes within a given sequence are gradual, but changes between units appear to be abrupt.

Unit 5, from 19.0 to 21.5 cm is moderately coarse-grained, and shows the reverse of the droplet succession described above. The lowest 5 mm is fine-grained, but is followed by a maximum in compound droplets, succeeded upward by double, and then single droplets.

Units 6-10, included in major unit B, contain single, double, and compound droplets, but appear to show transitional and cyclical successions of droplet type, rather than asymmetric non-transitional successions. Units 6 and 10 appear to be average, for the major unit, and units 7 and 9 are coarser than average, unit 8 finer than average.

Unit 11 has characteristics of major units B and C; it has the abundant vitreous glasses and compound droplets of superunit B, but has dull appearance and flaky fracture of major unit C.

Units 12 and 13 show the droplet succession seen in units 2-4, and differ from those units only in being slightly finer-grained.

A summary of these units appears in Fig. 3, with textural parameters in Fig. 4 and dissection splits in Fig. 5.

## CITED WORKS

- Apollo Field Geology Investigation Team (1975) USGS Interagency Report, Astrogeology #73, 316p.  
Butler, Patrick, Jr. (1973) Apollo 17 Lunar Sample Information Catalog. JSC 03211 Special Publ., 447p.

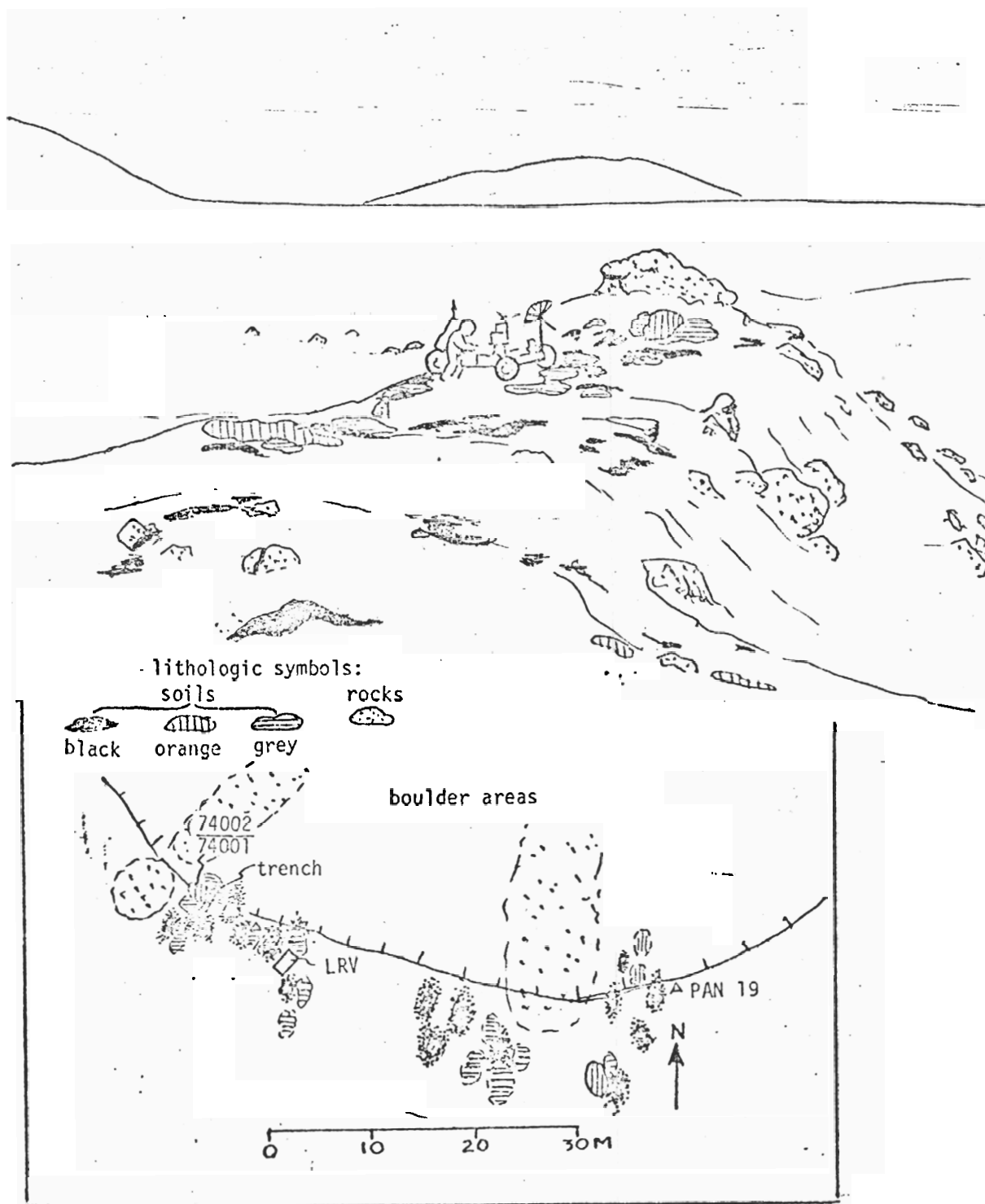
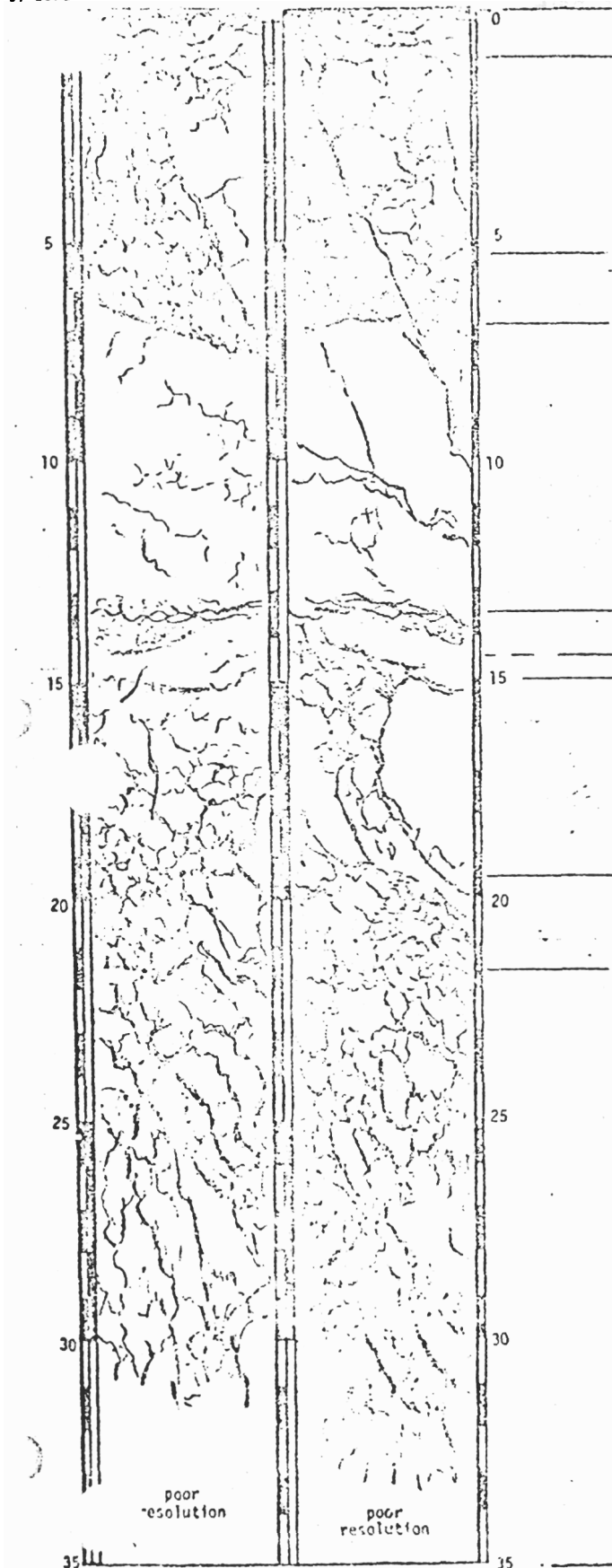


Fig. 1. Sketch of south rim of Shorty Crater, showing areas of orange, black, and grey soil as seen in PAN 19, and planimetric sketch map depicting distribution of areas of colored soil.

STEREOPAIR 1 (radiographed head-on with respect to number on outside of core)  
STEREOPAIR 2 (radiographed at 90° with respect to number on core)  
cm. below top of core



Interval Unit	Boundary	Description of Unit
-0.3 - 1.0 cm.		Partially void with equant clods or clasts averaging slightly less than 1 cm. in diameter, and with sub-rounded edges. Transverse fractures predominate.
IX		
1.0 - 5.5 cm.		Relatively massive unit with approximately 75% clasts and 25% matrix. Clasts average 2 cm. in diameter, and range in size down to 4 mm. The clasts are mostly equant, with relatively straight edges. A major inclined fracture cuts this unit, as seen in stereopair 2.
VIII		
5.5 - 7.0 cm.		Indistinct transition
VII		
7.0 - 12.5 cm.		Massive unit with dense internal appearance, with no clods or clasts internally, but a transverse fracture system at 13.5 cm.
VI		
13.5 - 14.5 cm.		distinct bowl-shaped contact, convex downward
V		
14.5 - 15.0 cm.		distinct, curving contact, convex downward
IV		
15.0 - 19.5 cm.		distinct curving contact, convex downward
III		
19.5 - 21.5 cm.		transition
II		
21.5 cm. to base of core		Indistinct but planar contact
I		

NOTE: The whole of core 74001 is relatively opaque and resistant to X-rays, and is interpreted to be composed entirely of the fine-grained black devitrified glass that was reported by Astronauts Cernan and Schmitt to occur at the top and bottom of the core (Bailey and Ulrich, 1975, p. 154). Core 74002 showed alternating layers of radiographically opaque and transparent material, with the transparent material occurring toward the lunar surface, at the top of the core. Vitreous glass passes X-rays whereas the crystal planes in the devitrified, crystalline glass scatter the X-rays, making it radiographically opaque. Therefore it is believed that the orange glass is confined to the radiographically transparent zones in 74002.

Within 74001, there are no density or opacity changes suggestive of rock fragments; instead, most changes are seen as obliquely intersecting zones of slightly lower opacity, suggestive of internal fractures. However, at the top of the cores, there are some clods of dark glass. The clods can be distinguished from fracture polygons by being relatively rounded, with edges which fade out rather than terminate abruptly. Furthermore, adjoining edges of fracture polygons fit together whereas edges of clasts are discordant. Sizes of internal polygons varies throughout the core, enabling identification of discrete zones which are interpreted herein as being parts of more extensive strata.

PRELIMINARY STRATIGRAPHIC SUMMARY, DRIVE TUBE 74001

X-RAY UNIT		SAMPLING INTERVAL	MAJOR LITHOLOGY UNIT	UNIT SAMPLES	LITHOLOGIC DIFFERENCES FROM MAJOR UNIT
IX		0.0			
				13 ,21- ,26- ,30	internal droplet succession multiple double single
VIII		2.5	flaky cohesive, dull in appearance, poorly sorted with abundant devitrified C fines, random internal fabric.	12 ,31- ,37	internal droplet succession multiple double single
VII		5.5			
		7.0		11 ,38- ,41	seems transitional to B and C; has dull appearance as above, vitreous glass and compound droplets as below
VI		10.0	massive and strongly cohesive, relatively reflective and sparkly in appearance, relatively coarse and sorted with abundant vitreous B glass droplets, internally stratified.	10 ,42- ,46 9 ,47- ,53	characteristics of major unit concentration of large droplets
V		13.5		8 ,54- ,55	relatively fine-grained
IV		14.5		7 ,56- ,57	relatively coarse-grained
III		15.5			
				6 ,58- ,64	characteristics of major unit
II		19.0			
				5 ,65- ,69	internal droplet succession multiple double single
I		21.5			
		24.0	flaky cohesive, dull in appearance, poorly sorted with abundant devitrified fines, random internal fabric	4 ,70- ,74 3 ,75- ,81	internal droplet succession, as above internal droplet succession as above
		27.0	A		
				2 ,82- ,88	internal droplet succession as above
		30.0			
				1 ,89- ,97	relatively homogeneous unit, with scattered but large compound droplets, unusual horizontal grain alignment at 30 cm. (top of unit).
		34.3 (base of core)			

18 5

PRELIMINARY PETROGRAPHIC DATA, FIRST DISSECTION OF DRIVE TUBE 74001

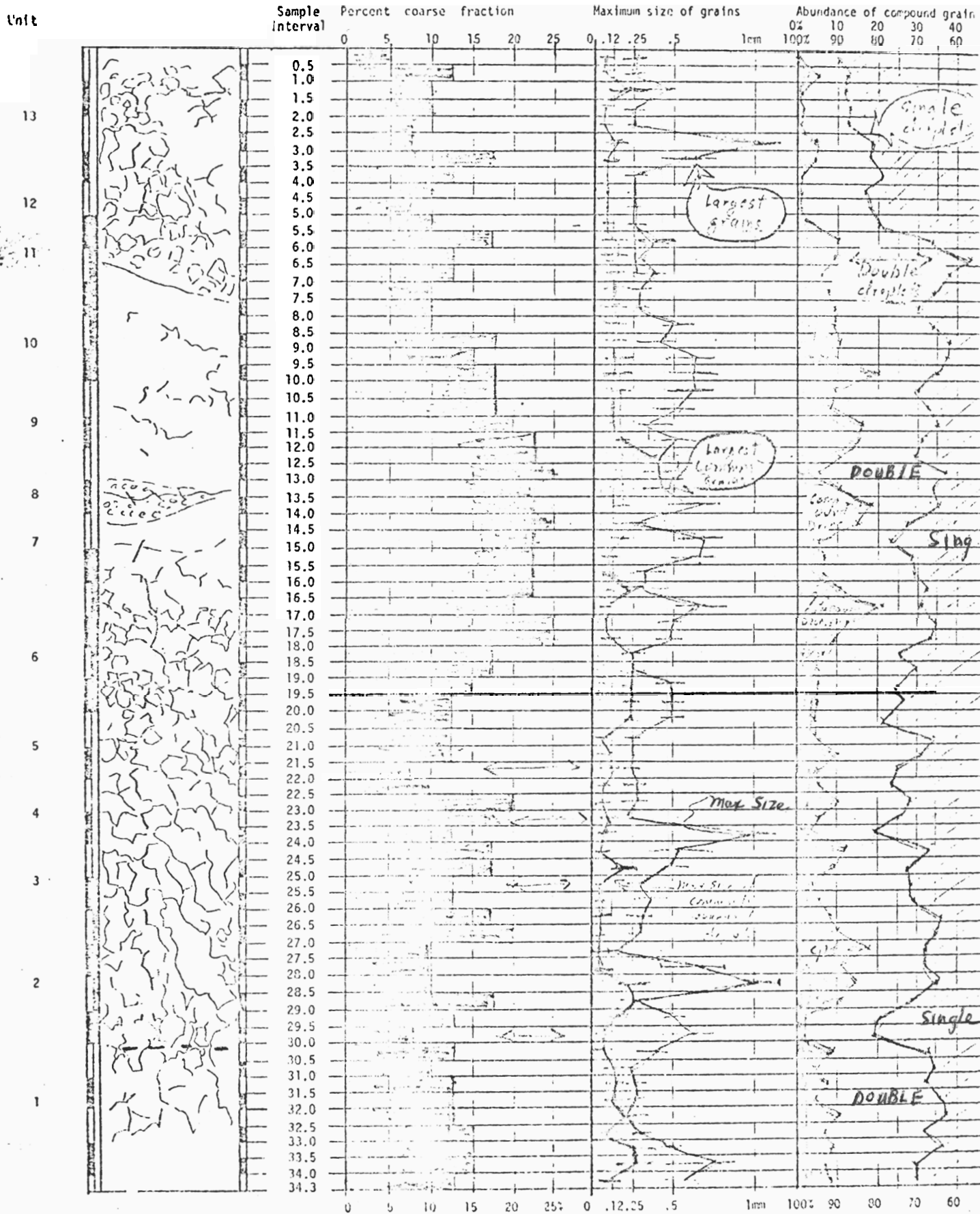


Fig 4

(5)

## SAMPLE LOCATIONS, FIRST DISSECTION, DRIVE TUBE 74001

UNIT	Sample Interval (LCL Inventory)	INTERVAL SAMPLES			COARSE FRACTION		
		Sample No.	Vial No.	Sample Wt.	Sample No.	Vial No.	Sample Wt.
13	0.0	21	9-11001	2.430	(material removed from top of core before extrusion)		
	0.5	26	9-11001	0.250			
	1.0	27	9-11002	1.181			
	1.5	28	9-11003	1.133			
	2.0	29	9-11004	1.091			
	2.5	30	9-11005	1.405			
	3.0	31	9-11006	1.295	32	9-11007	0.002
	3.5	33	9-11008	1.445			
	4.0	34	9-11009	1.347			
	4.5	35	9-11010	1.551			
	5.0	36	9-11011	1.280			
	5.5	37	9-11012	1.506			
	6.0	38	9-11013	1.454			
12	6.5	39	9-11014	1.354			
	7.0	40	9-11015	1.373			
	7.5	41	9-11016	1.411			
	8.0	42	9-11017	1.460			
	8.5	43	9-11018	1.307			
	9.0	44	9-11019	1.499			
	9.5	45	9-11020	1.507			
	10.0	46	9-11021	1.513			
	10.5	47	9-11022	1.329			
	11.0	48	9-11023	1.445			
	11.5	49	9-11024	1.569			
	12.0	50	9-11025	1.368			
	12.5	51	9-11026	1.331			
9	13.0	52	9-11027	1.656			
	13.5	53	9-11028	1.158			
	14.0	54	9-11029	1.356			
	14.5	55	9-11030	1.384			
	15.0	56	9-11031	1.525			
	15.5	57	9-11032	1.440			
	16.0	58	9-11033	1.495			
	16.5	59	9-11034	1.521			
	17.0	60	9-11035	1.603			
	17.5	61	9-11036	1.298			
	18.0	62	9-11037	1.531			
	18.5	63	9-11038	1.431			
	19.0	64	9-11039	1.447			
8	19.5	65	9-11040	1.577			
	20.0	66	9-11041	1.450			
	20.5	67	9-11042	1.394			
	21.0	68	9-11043	1.514			
	21.5	69	9-11044	1.427			
	22.0	70	9-11045	1.590			
	22.5	71	9-11046	1.333			
	23.0	72	9-11047	1.641			
	23.5	73	9-11048	1.394			
	24.0	74	9-11049	1.505	75	9-11050	0.003
	24.5	76	9-11051	1.494			
	25.0	77	9-11052	1.534			
	25.5	78	9-11053	1.476			
7	26.0	79	9-11054	1.443			
	26.5	80	9-11055	1.503			
	27.0	81	9-11056	1.502			
	27.5	82	9-11057	1.485			
	28.0	83	9-11058	1.461			
	28.5	84	9-11059	1.458	85	9-11060	0.005
	29.0	86	9-11061	1.556			
	29.5	87	9-11062	1.488			
	30.0	88	9-11063	1.555			
	30.5	89	9-11064	1.410			
	31.0	90	9-11065	1.656			
	31.5	91	9-11066	1.490			
	32.0	92	9-11067	1.486			
6	32.5	93	9-11068	1.580			
	33.0	94	9-11069	1.534			
	33.5	95	9-11070	1.305			
	34.0	96	9-11071	1.165			
	34.3	97	0-11072	0.894			